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Injuries to the Skull,

WITH SOME OBSERVATIONS ON
ONE HUNDRED AND EIGHTEEN CASES

BY

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INJURIES TO THE SKULL, WITH SOME OBSERVATIONS ON ONE HUNDRED AND EIGHTEEN CASES.

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After having an experience of now something more than seven years in dealing with various wounds of the body, and seen in that time more than a hundred skull fractures, I think, at least, it will not be claimed that I write without some extensive observation.

I have seen every square inch of the skull broken by causes of every description, by blows, falls, shots and punctures; and have seen many forms of modern treatment applied.

I now feel that my theme would result in very much good, if I could extinguish some of the delusions, which many are laboring under at the present time, through the rather bright-colored reports and intemperate enthusiasm, of a few contemporaneous writers, on traumatism of the skull.

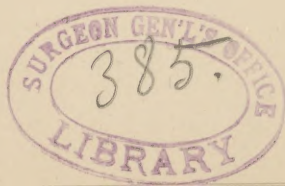
Sometimes morbid growths may be diagnosticated within the cranium, and sometimes, too, they are located, and the skull bored, but they are not found, and the patient dies. The removal of neoplasms from the brain is not a difficult procedure with a competent anatomist and dexterous operator.

So much having been generously contributed lately to us by well known members of our profession in this country and Europe, in the way of surgery of the head and its possible future, let us see how newer methods of treatment, and technique of operations, have modified or effected results.

Before dealing with lesions of the skull, it becomes necessary to review its anatomy and perhaps some of its physiology; but it seems indispensable that a thorough knowledge of structure is needed before one can intelligently discuss injuries, etc.

Of the three closed cavities of considerable size in the adult, the cranial, is the only one composed exclusively of bone. Oval in shape, the skull is formed of two layers, or plates of bone, with an interspace for cancellous tissue and blood-vessels, the veins of the diploë. The inner table is rather thinner and more brittle than the outer, and is lined by the dura mater. The outer is the stronger, thicker, and more elastic, covered by the pericranium.

The veins of the diploë run in grooved channels, have very thin



coats, and communicate through small foramina freely with the scalp externally, and the vessels of the meninges and the brain internally.

The walls of the skull undergo important changes in shape and consistence at various periods of life, and vary very much in different situations and individuals. They are laterally and above, arched; hence, so shaped as to resist in a great measure, the effects of force or pressure.

The brain substance, which fills the cranial cavity, is of an elastic, resilient, compressible character, varying in fulness and volume according to circumstances. It bears evenly and with uniform pressure against the broad, flat bones which encase it, and owing to its semi-liquid, pulpy quality, readily transmits vibrations, from one part to another; and though so carefully guarded against injury, in its bony encasement, it tolerates manipulation and even mutilation to a greater degree, without immediate danger to life than any other viscus of the body.

With respect to the circulation within the brain, we are all familiar with the divergent views of writers; some, maintaining that the cavity, being hermetically sealed, is not subject to atmospheric pressure, the quantity of blood being always the same. Others deny this, and hence, have sought to prove by experiment, that in *anæmia*, there was a diminution, and in congestion, an excess of the normal supply. Indeed, one well known physiologist says that the valves, in the jugulars, always prevent the blood current, from welling upwards, and over-distending the cerebral veins.

This is an erroneous assertion, for anatomists declare those valves, or *cul-de-sacs*, as incompetent; besides any one who has seen the exposed brain, knows that the venous system, within it, undergoes every variety of distension, as with every effort, while coughing, sneezing, or straining of any kind, the vessels greatly distend. Physicians have reported many cases of apoplexy, as due to straining at stool, resulting in over filling, and bursting of the vessels; and any one, who has seen a woman in the throes of labor, knows when a long severe pain develops and the breathing is momentarily stopped, how dark and livid the face becomes, and how the superficial jugulars stand out. However, to positively decide the matter, I have in four subjects, removed the jugulars from the neck, and tested the potency of the valves, and found, that in neither the superficial, or deep vessels did they offer the least resistance to water injected from below.

We must conclude, then, that the quantity of blood in the brain, or sinuses, is not always the same, in health or disease. The brain tissue through its compressibility, and elasticity will adapt itself to moderate distension of the vessels without injury, and through its expansive

properties, readily fill the void occasioned by a limited withdrawal, or diminution of the blood supply. So that it is perfectly compatible, with physiological function, to find the volume of the circulation undergoing variations.

I have a case in mind now, a living proof of the full truth of this assertion, which is not based on theory, but actual fact.

The circulation from the brain through the diploë to the scalp is very intimate, as both plates are freely perforated with foramina for the transmission of veins and arteries. The anatomical relations are important to bear in mind here, as we see in erysipelas how quickly through this connection, the brain becomes involved and the sensorium profoundly affected, meningeal inflammation frequently following.

We can take advantage of this knowledge, too, when we apply cool lotions to the head in congestion and inflammation, as when we often see them judiciously applied, they are without a rival, in quickly crushing that burning heat, of high inflammatory action.

The great venous channels we find mostly—fortunately for the surgeon—at the base of the brain. The longitudinal sinus is the largest vessel found in the cranial roof. From the brain substance we next come to that serous membrane, which lines the skull, and covers the brain. It has always seemed to me a great misfortune that anatomists by their complex and confusing description of this lymph-sac should have so embarrassed and discouraged students, and practitioners, that very few have a clear idea about this structure.

Why it has not been described as the peritoneal or pericardial-sac in a general way, as all its layers and reflexions are, histologically and physiologically, similar, if not exactly the same, seems difficult to understand, as it would very greatly simplify its description and study.

The dura mater or covering of the internal surface of the skull is a fibrous membrane, similar in structure and function to the aponeurotic lining of the abdominal cavity, except that it is thicker and denser. It has an extremely thin serous lining, is loosely adherent to the bone, and is rather a true covering of bone, than brain tissue. Some attribute to it the power of reproducing bone, but I have never yet seen evidence of this. Surgically considered, it is a most important structure, as it forms the real tangible boundary line between the skull and brain.

Lying immediately beneath it is the true serous membrane of the brain, the arachnoid, which divides the arachnoid from the sub-arachnoid cavity and covers the entire brain. The arachnoid cavity is readily demonstrable, but the subarachnoid is more easily imagined than demonstrated *on the cadaver*.

The nutrient vessels of the convolutions lie in this membrane, and through processes given off from it, dip down and nourish the superficial structure of the cranial contents. The pia mater—or what I would rather designate it—the thinnest and deepest reflexion of the arachnoid lies closely on the brain substance.

The source of sensation within the head is no doubt lodged in the meninges, as like the pleura and peritonæum, the serous coverings of this viscus are the principal means through which sensation is transmitted. I have many times had an opportunity to prove the utter insensibility, of cerebral and cerebellar tissue to irritants.

Wounds of the arachnoid, heal readily. Not so, however, with the dura mater, as we shall find when we come to deal with lesions of it.

The cranial bones are of a formation peculiar to themselves. They have no medullary substance, hence no osteoblastic layer for the regeneration of bone, but on the other hand, in middle life and youth, they are separated into two plates; the interspace occupied by cancellous tissue through which ramify the blood-vessels of the diploë. This interosseous structure becomes mostly obliterated in old age. The vessels of the diploë are very small, but in fractures of the inner table, they are capable of doing a vast amount of mischief through the large quantity of blood, which escapes from them into the brain.

In some cases of fracture of the skull through both plates, where there have been very large effusions of coagulated blood found lodged between the dura mater and bone, I have often seen no rupture of vessels in contact with the extravasation, to account for it, except those through the cancellous tissue.

We can easily see why this should be, particularly when the outer tissues have not been lacerated, by the fact that fluids always go in the direction of least resistance, the dura mater being but loosely connected with the skull is easily detached, allowing the blood to insinuate itself underneath it, while the pericranium is firmly adherent and removed only with considerable force.

With advancing years—after fifty—the cancellous tissue of the skull disappears almost entirely, and both plates fuse together, so as to form really, but one.

At advanced life, owing to the want of organic elements in the osseous tissues, the cranial walls are brittle, readily fractured, and at this time too, a breach in their continuity becomes more dangerous, in fact, is nearly always fatal.

In very early age, on the other hand, when ossification is not complete, the bony covering of the brain will tolerate quite extensive injury, provided there has not been much blood lost, or the meninges ruptured, with remarkable impunity.

How many times we have seen the skull crushed in, in delivery with the forceps; indented deeply in many places; yet in a short time, adapt itself to the normal form?

Children I have found, too, recover well from fractures, *when the destruction has not been too great.*

Owing to the tendency of depressed bone in youth, to resume its former position, and the fact that children proverbially bear the loss of blood badly, I think we should be extremely cautious in cutting down on fracture or suspected fracture if they are injured about the head.

Immediately over the outer surface of the bone, we come to the true periosteal covering of the skull, the pericranium, a very thin but strong and firm tissue, very adherent to the bone; in some situations, especially under muscular attachments, it is very closely incorporated with the underlying bone. This covering alone, is ample to supply both plates of bone beneath with nutriment, and is the only one, capable of reproducing bone-tissue.

But, even this membrane, I believe, possesses the latter property, in a very feeble measure, and then, only in early life. In simple scalp wounds of the head, the integrity of this tissue is seldom impaired.

Being so closely in contact with the bone, nothing, scarcely, will make a breach in it, short of a fracture; and even here, if there is not decided depression of bone, it will stretch but not tear; hence, I have more than once seen internes, after making an exploratory incision, overlook a fracture, by not taking the precaution to *scrape* away, or elevate this thin, gauze-like covering.

Above the pericranium, between it and the aponeurosis of the occipito-frontalis, besides more or less fat and areolar tissue, we find a distinct fascia, capable of easy dissection, covering the entire head above, but not beneath the muscular attachments. It is well developed, containing fibrous tissue mostly, rather stronger than the superficial fascia of the thigh, but thinner than the fascia-lata.

I am quite sure, that it is this tissue, which sets the inexperienced astray, in searching for fracture after an injury. They mistake it for the proper external bony covering; and the pericranium being so extremely transparent and thin, they imagine *it* is the smooth, bare surface, of the bone itself.

The parts between the bone, and the under surface of the aponeurosis, are very vascular.

The broad fibrous expansion, which bridges over and joins the frontal with the occipital muscle, is closely connected with the scalp by connective tissue, and in some individuals is quite movable. It is hard to conceive what purpose it serves in man, but those, who have to do with head injuries, know that its presence is often a source of annoy-

ance. Very large, and numerous vessels, pass immediately above this, through the scalp. The vessels here are especially noticeable for their thin coats, and abundance.

The hair bulbs penetrate very deeply, and seem in some situations, to even blend with the fibrous elements of the aponeurosis. The hair of the head would seem to serve the purpose of regulating the heat of the tissues beneath; certainly, in modern times, when it is mostly clipped short, it can serve no useful purpose, in moderating concussion from falls or blows.

The base of the skull, so far, has hardly been accessible to the surgeon, as we are only *positive* of a lesion in this situation when we see it, *post-mortem*.

I think it well to consider some of the fleshy lesions of the head while discussing injuries of the skull, for we seldom have the latter without the former.

The kind of injury most frequently seen in this region is the contusion. The head receives a sudden, sharp blow or fall; and the vessels being crushed between two hard substances give way, followed by free leakage into surrounding parts. Quite a large bump (*hæmatoma*) will often arise from only a moderate blow. When the force applied is very great—sufficiently to seriously jar or damage the brain—this tumor does not appear; something, I think, which is attributable to feeble heart action, shock; the blood not being effused, or forced into adjacent tissues.

It is interesting, too, to watch with what despatch and completeness the circulation will usually absorb every remnant of this large blood-clot. In twenty-four hours, the largest have faded out of sight. These *hæmatomata* often produce a sort of concave cupping at their base, which would occasionally lead a person to suppose, there was a depressed fracture, in this situation; but if there is doubt and no marked head symptoms, it is well to wait and see, how things will be after the clot has disappeared.

Lacerated wounds of the scalp are seldom seen, except associated with contusing or bruising of the parts. Their edges are irregular and jagged. We often find them of great extent. I once saw the entire scalp torn off, in a woman, by having her long hair caught in a revolving shaft.

The police do fearful execution on the head with their long, heavy hickory clubs. A sharp, swift blow from one of their night bludgeons, though with round edges, will cut the scalp and lay it down over the ear, as neatly as a knife; and here we will find a wide deviation from

the rule, laid down by older surgeons, about lacerated wounds seldom bleeding. We have torrents of blood. No ordinary pressure or stipitics will control it. Either, we must twist, or tie the arteries securely, before we close the wound.

Scalp tissue is very prone to heal; when there is no septic infection, more quickly than any other, in the body.

I once saw this well illustrated in a lunatic who, when alone, first, by pounding his forehead against the edge of an iron sink, detached the scalp anteriorly from ear to ear, and then tore the whole, down over the back of his neck, before discovered; when he was very faint from loss of blood. The parts were promptly replaced, and he made a good recovery.

We may have very serious lesions of the skull or brain without any visible lesion of the scalp; but the converse is much more frequent. How often do we see "cut heads," tears, and contusions of the scalp without any cerebral complications whatever?

Now, having noticed briefly the immediate coverings of the skull, and their peculiarities, it is in order to consider the lesions of the bone itself—fractures of the skull; and they cannot be intelligently considered without touching on the surgery of the brain.

In text-books and monographs on fractures, we seldom see anything on lesions of the cranium, as though the authors decided this region one which should be considered by itself; as though tissue formation and bone repair here, were different from elsewhere, and, accordingly, should be dealt with as a separate part of the body.

When we look into the marked, and striking anatomical and histological difference, in this structure, we can see at once, that the general principles on which ordinary breaks of bones are treated, will not apply here.

We have no true periosteum as a bone covering; no medullary canal; no large muscles to deal with, or great arteries. We have no provisional callus; and, notwithstanding all that has been said and written by recent writers in the affirmative, I do not believe that the membranous coverings of the cranium in adult life possess, in but the slightest degree, the power of reproducing bone.

Though the head contains organs vital to life, it will stand battering and bruising, with greater impunity than any other part of the body.

Wounds of the head seldom become dangerous to life, except when its walls are crushed in; and in certain stages of life, the cranial contents will safely sustain a wonderful amount of compression and displacement, without in the slightest degree impairing their integrity. I have seen the skulls of children extensively shattered without the child

manifesting the least mental derangement, the bones quickly coming together, and gaining their wonted strength, and firmness. Those of us who have ever attended confinement can bear witness to the extent of pressure and distortion the infant's brain at birth will safely endure. We have seen the head sustain the crushing force of the heavy steel-bladed forceps, in strong hands, for hours; afterwards delivered with it deeply indented in places; and yet, with all this squeezing and mutilation, no convulsions. On the other hand, in the course of twenty-four hours, we were amazed at that curious power, which the skull possesses at this age, of obliterating those deep indentations, and resuming its normal shape.

The majority of skull fractures are mortal, but the mortality depends upon many circumstances. First of importance is age; secondly, the extent and location of injury; thirdly, the manner in which the force is applied, whether direct or indirect; fourthly, the treatment.

In the last seven years I have seen one hundred and eighteen cases of fractured skulls. The results I will tabulate later on. Suffice it to say at present, the younger the patient, the better were the chances of recovery.

With those who have reached the meridian of life, or passed it, it is different, as at this stage the bones are hard, brittle and less elastic, the inorganic elements preponderate, the cancellous tissue and diploë are being obliterated; so that late in life, we find the interspace entirely obliterated, and all a solid mass of compact tissue.

The location and extent of injury. Next to the base of the skull, probably a fracture through the temporal bone is the most fatal.

I can account for it, only on the supposition that because the bone here is so thin and yielding that sufficient violence to fracture it, must do great damage to the brain.

Fractures through every part of the calvarium are frequent, the skull being thinner, and more exposed in this situation.

We can seldom estimate the extent of internal or brain injury, or foretell results by the size or limit of a break or breach into the cranial walls, as it is well known that the inner table may be extensively shattered, without any depression, or fissuring of the external; and we know, too, that a small puncture through the walls, with a stiletto or sharp-pointed instrument, may be followed by direful consequences.

On the contrary, we occasionally see extensive fissures, radiating in every direction, but no serious difficulties following, no impairment of the vital power, and a complete recovery.

We not infrequently encounter a sort of intermediate kind; those which are brought in, simply because they think they are badly injured.

They have trivial symptoms, eat and sleep well for a time, finally after a few days become stupid, drift into coma, and die if relief cannot be given.

I have seen quite a number of this description. One of the most remarkable was a man who attempted suicide. He had fired four shots, at short range, into his head, when discovered. At this time he was bleeding freely. The house-surgeon probed the perforations in the scalp, made by the bullets, and owing to the immense thickness, swelling, and puffiness of the tissues, supposed that all entered the cranial cavity.

When I saw him in the morning, I cut down freely on to the skull. The four balls were found flattened, on the pericranium. They were easily removed, and he was apparently recovering from the effects of the flesh wounds, when his temperature went up; he got paralysis and convulsions, dying in twenty-four hours after those were manifest. After death the skull was found fissured, and pus formation, in abundance, under the bone.

I have in mind three other cases, one of which occurred recently and was reported in the *Medical News*. The first came under my observation while on duty at the Workhouse. This woman was arrested in a drunken brawl, the officer securing the arrest, having to make free use of his locust. A magistrate committed her for "three months" the following day. After she "sobered off," the senior medical attendant on duty examined her, and found nothing wrong; but five days after entrance she had a fit, and died, within twelve hours. After death a fracture was found in the temporo parietal region, with a large clot underneath.

In my recent case, though our man was dazed on entering the hospital, he recovered reason, but again became lethargic. Here, again, we found a large blood-clot in the same region, as was the pus in the former, and it was readily and successfully removed, under the influence of morphia during life. Death followed a few hours later, when another fracture of the base, extending from the large foramen forward, was discovered.

When we are reasonably assured, that the base of the skull is involved, death is inevitable, and treatment is out of the question.

Much depends on the kind of force which is applied, whether direct or indirect; whether the lesion in the cranium was inflicted by a blow or a fall.

Fractures resulting from falls, in this situation, are altogether more fatal than those caused by blows or missiles. This can be quite readily understood, when we bear in mind that the blow does only local damage; while a fall jars the whole body, often producing quite serious internal destruction, independent of the injury to the encephalon.

The Treatment of Skull Injuries.—Here, indeed, we come to the knotty part of our subject. While great advances have been made in surgery, during the present century, yet, notwithstanding all that has been recently published by contemporaneous writers and enthusiastic investigators, there still remains much diversity of opinion on this subject. We can hardly say that anything under this head has been *definitely* settled.

It must not be forgotten that this question was profoundly studied by the greatest military surgeons of the past: many of whom had extensive experience in the wars of their time: when the modern, rapidly-firing, breech-loading, long-range musket of modern times was unknown; when the cavalry arm of the service did terrible destruction with their broad, heavy sabres, and battle axes, on the heads of the contending foe; when the bayonet-charge was more frequent, and fighting at close quarters common—the infuriated hosts dealing death and destruction with the butt ends of their carbines.

The main part of the controversy *was, and is, on interference.* Shall the surgeon use the elevator or trephine, and elevate or remove the depressed or fissured bone?

Is the operation itself so simple and harmless, as to be unattended with danger, or followed by unpleasant consequences? And again, not less important to be considered, is the next question: Are these depressions, or fractures, *always* a source of impaired cerebral action, and their presence a menace to healthy brain-function?

I am convinced, by practical experience, that, in a general way, we may answer both questions in the negative.

The trephine is an instrument capable of doing much harm, no matter in whose hands it is manipulated. The healthy brain will safely bear considerable compression, with perfect immunity, so long as no spiculum of bone is driven into it.

We must, then, when we come to decide the question of perforating the skull with the large, modern trephine, and of even enlarging this spacious opening with the rongeur, consider what the ultimate results will be as regards this extensive mutilation. I have occasionally experienced almost insurmountable difficulties, in the *after-treatment*, when the trephine is used.

I think it well to hesitate, when there is simple depression of bone, with *no pronounced* brain symptoms, before we open on to the brain with the trephine: not that the operation is difficult or always dangerous, but that its use may be followed by that *bête noir* of brain surgery *cerebral hernia*.

We may safely predict reasonably good results after the trephine, provided the dura mater has not been lacerated; but if this tissue is

divided and the convolutions disturbed, we may look out for protrusion of brain substance—a condition for which there is no remedy.

Billroth says that brain tissue does not renew itself when *once* destroyed. This may be so, but no one will deny, who has ever seen cerebral protrusions, that a soft, fungous substance, much resembling brain tissue, will grow, *and budge up through*, as fast as it is cut off.

I have found, when the dura mater allowed this mass to pass outward, it will so push through the uniting edges of a scalp wound as to quickly tear them asunder and prevent adhesion of the edges.

As we may look for this troublesome sequela of the trephine, we should always at the primary dressing see to it, that, if necessary, the torn edges of the dura mater are sutured, *when possible*, with fine catgut; the whole well covered, and compressed till primary union is secured.

While speaking of the opening made in the tissues of the head, for the trephine to reach the bare bone, this seems the place to mention the fact that, in fractures of the skull, scalp wounds sometimes cannot be closed at all.

One cause has been stated—brain-protrusion; the other, an opposite condition, is collapse of the brain: and as neither can be successfully treated in every instance, there will be a few irremediable cases.

I will here cite a case of the latter condition. My patient, a man of twenty three, while returning from work was struck on the side of the head with a brick. Shortly afterward the same evening he was arrested and locked up. The following day a judge gave him a “ten-day sentence.” While awaiting transportation, in the district lock-up, he had a slight convulsion.

He was sent to the hospital, when it was found that he had a scalp wound over the left ear, but no fracture could be discovered. He now took to bed, complaining of dizziness and constant pain in his head.

His bowels were moved with salines; but the pain continued. He remained in about the same condition, except that after the first week he was about the ward most of the time.

At no time did his temperature go up above 99°. After he had been in the hospital about a month the house-surgeon, Dr. Walsh, one morning informed me that the scalp wound was not yet healed, and wished me to see it.

I found the edges of the wound inclined to retract; and in the centre, which was quite bare, I discovered a thin seam of granulation tissue sprouting up through a fissure in the bone.

When I saw this I was quite sure there was mischief going on be-

neath the bone, though we found no symptoms to indicate it except this suspicious condition of the osseous tissue.

When this fissure in the bone was seen, I made gentle pressure on each side, and pus oozed through.

The small trephine was now applied, and it opened into a large abscess *outside* the dura mater. A large quantity of pus was voided by turning the head on its side, and emptying it as one would drain a jug. After being emptied, and well irrigated, the cavity was filled with warm water, with a view of estimating its capacity, when we found that six ounces were poured in before it was full.

He was permanently relieved of the headache, but the cavity has not diminished in the slightest, nor have we been able to close the opening made through the skull with the trephine.

It is now nearly two years since the accident; the port-hole and void in the skull remain without giving him the slightest inconvenience. By gently passing in a probe, the boundaries of the cavity can be easily defined—the surfaces of the dura mater and the skull being firmly united around its base. The pulsations of the brain are readily seen through the opening.

We tried in vain to close the aperture in the skull by every kind of plastic operation; the edges over the hole, however, would every time either retract or ulcerate, and we gave it up. I may say that the only time we *ever saw* the brain *fill* the opening up flush to the inner plate was when our man was etherized; but as he came out of the anæsthetic, the brain again receded. This case was quite remarkable. Here we had extensive suppuration without any fever, and most decided compression without a *single* untoward symptom.

The old dictum is not without its force and usefulness to-day, viz., that we are often justified in not applying the trephine until some *well-pronounced* or grave cerebral disturbance calls for its use. It is not enough that there is some slight compression, or even a fracture, if the latter is of very limited proportions, and there is no displacement.

Surely, this may seem strange language in these days of progressive surgery, when we read of operators removing whole slabs of the skull-walls, and exploring the compartments which they enclose, with the greatest indifference. Indeed, a casual reader would suppose it quite a simple affair, especially when we are told the removed bone can be successfully reset and firmly implanted in its former position. No one will question, that bone carefully removed with a very fine trephine, from a *young*, healthy skull, will occasionally take on vitality; or form *fibrous* adhesions with bony tissue about it; but I do deny, when the bone is crushed by *violence*, especially in *elderly people*, that this ever takes place. The chasm must remain. The trephine may wound the dura mater.

Owing to the oval form of the skull, the broad trephine is pretty certain to do this every time.

To be sure, in cutting down for a tumor, this is not of much consequence, as it must be divided anyway; but when we are simply using it with a view of elevating, it is a different matter.

Sometimes, if we do not bear in mind the great danger of brain protrusion, we may leave our patient in a condition more lamentable than when we first saw him.

The closing of the scalp wound, after perforation, is sometimes impossible. I saw, in the *Lancet* of January 26th, 1889, the report of a trephining case, by Heath, of London, in which he acknowledged he could not, by any means within his reach, close the opening. This fact is important to remember, when we consider the question of tapping the cranial vault. I cannot offer any explanation for it, except that there is nothing to support the under surface of the scalp tissue when the brain sinks away from the surface of the bone.

However, when it becomes imperative to bore the skull, it seems to me, after drainage is established, in closing the wound the tissues should be taken up, when possible, layer by layer, and sewed *separately*, the pericranium, sub-aponeurotic fascia, the aponeurosis and scalp. This, at least, would favor immediate and compact union.

I do not wish to be understood as opposed to the intelligent use of the trephine; but I do insist that the conditions requiring it be well defined before we take it in hand, and, further, to impress on those who may not be familiar with it some of its drawbacks.

The distinguished English surgeon, Bryant,¹ describes a class of brain injuries in which, without doubt, the trephine is invaluable—those in which there is no apparent injury to the cranial coverings after an accident; but, where in time an otitis commences and extends towards the meninges. Here a timely opening into the diploe or bone substance, in relieving tension and depleting the engorged vessels, would have a most happy effect. He advises, however, before resorting to this procedure, to freely bleed and purge.

The technique of an operation on the skull is similar to other parts of the body.

The most thorough antisepsis having been provided, the head should be freely shaved and scrubbed and shampooed, to secure perfect cleanliness. Cat-gut suture is preferable if we look for primary union. The dressings should be of such a fluffy, absorbable character as not to need removing until union is complete, unless to displace the drain or for some special symptoms.

Erysipelas, that frequent sequence of a tear in the scalp, has been

¹ Bryant, London *Lancet*, July 14, 1888.

banished under rigid antisepsis; and there is no lesion more satisfactorily managed now than wounds of the scalp, when they *do not* penetrate the brain.

Large hæmatomata, when it appears that their volume is too great for absorption, and they enormously distend the scalp tissues, should be freely and promptly opened, care being taken to make a free incision, so that if a vessel is supposed to be leaking its bleeding orifice may be exposed and secured.

In every instance where I have opened those large blood tumors, I have found them in the sub-aponeurotic fascia; hence the necessity of carrying the edge of the scalpel in the direction of the large fibres of the aponeurosis from before, backwards, in making the opening. In the small hæmtomata bumps the rupture of vessels is more superficial, being nearly always, in the hairy scalp, near the surface.

With an opening into the skull, by fracture, our dealing with the wound becomes complicated and difficult; but an effort should be always made to secure prompt union. The scalp makes an ample covering for the brain, in locations where considerable portions of the skull have to be sacrificed, and where the dura mater is not wounded.

A wound of this tissue, however, as I have before stated, is a most serious complication. I consider it so great a calamity that I question even the justifiability of sacrificing its integrity in exploring for cerebral tumors. This may seem extreme language. True, now and again a tumor is found and removed; and true, also, it is that the brain is now and then extensively mutilated in searching for a tumor that never existed. But supposing the tumor is enucleated, is the patient any better after than before?

Usually he will have paralysis, often convulsions, and always more or less extrusion of fungous brain tissue, which will surely shorten his life.

It would be interesting, *if all* who open the cranium and explore the brain, would give to the profession a report of these cases, successful and unsuccessful, at the time of operation and a *year or two later*.

It is always well to make a free incision into the scalp, so that we can well expose the bare bone when about to open the skull, as it gives us much more space to manipulate in, and besides the larger incision will close as readily as the smaller.

In dealing with hæmorrhage, we may use either compression or the ligature. Of the latter I can speak confidently, as my experience with it, under certain circumstances, has been most gratifying.

When compression will not suffice, and you cannot draw out and secure the mouths of the spouting vessels, and when clamps are in your way, I have used with great ease and success what may designated "the temporary transfixion ligature."

I can find no mention of this most useful expedient to the operator in any work. You simply take a single or double ligature, according to the size and depth of the vessel, with a curved needle, taking care to carry the point below the vessel, *close to the bone*, and bringing it out near to where it entered, then tying the ends sufficiently tight to stop the hæmorrhage. I use one or more, as may be required, on any kind of vessel, vein or artery, large or small.

By this means, bleeding is most expeditiously controlled, and we are permitted to go on leisurely with our operation.

When we are through, we remove the ligatures, and, if the divided vessels are small, all bleeding has stopped, and we close the wound. On the other hand, if there is a large vessel included, it gives us an opportunity to find and tie its retracted ends.

We will meet with hæmorrhage mostly in two situations, viz., external and internal to the broad aponeurosis—in the scalp tissue and in the sub-aponeurotic fascia; in the latter we most frequently encounter the bloody effusions, hæmatomata.

If very great caution is not taken, the peri-cranium will be overlooked in exploring for suspected fractures. I find, in nine cases out of ten, inexperienced young hospital surgeons mistake the sub-aponeurotic fascia for it, and will claim that they divided everything down to the skull in their search, but the pericranium is yet untouched.

One who has made many careful dissections here, cannot blame them for overlooking it. The pericranium is so extremely thin and transparent that, if great care is not exercised, we will imagine we see the bare skull, while this covering yet remains intact. It requires good eyesight, as well as a concentrated light, to readily identify it.

If we wish to preserve the tissue, with a view of sewing it separately, when we close the wound we may *sometimes succeed* if we *scrape* it up very delicately with an elevator. We will very often fail, however, no matter what care is taken, in detaching it entire.

Over the sutures it is almost blended with the bone itself, and cannot be raised without tearing. We meet with the same difficulty in regions of the head where muscles are inserted into it.

In skull fractures it is always badly torn; so that, when we hear of this being *served together* after these injuries, if we are profoundly skeptic, it should not be wondered at, for the reason that it is an utter impossibility in many cases. We find the osseous tissue of the skull of every consistence; in one the trephine going readily down to the meninges, while in another its hardness seems like ivory, the teeth of the instrument penetrating it only with great difficulty.

Very often we may be able to elevate depressed bone by the use of Hey's saw, or the elevator.

The hæmorrhage from the diploe may be of a very troublesome kind. When this is the case, we must use pressure, or plug the vessels.

It very seldom happens, however, that more than ordinary means are required to control it. Bleeding within the cranial vault, though occasionally quite free, is seldom immediately dangerous. I have seen every square inch of the skull opened except the base and petrous portions, even over the lateral, deep, and the great, long sinus, but there was no instance in which life was jeopardized, or that firm continued pressure did not suffice to stop bleeding. In these days of antiseptics the drainage-tube is used in open wounds of the skull penetrating the brain. Where the fracture is through the vertex they do more harm than good, for the simple reason that you cannot drain a man's skull in this situation unless you stand him on his head. However, if it is desirable to keep the wound open with a view of removing all effete matter, a small twist of gauze may be passed in and changed with each dressing.

We must deal with the scalp on general principles when it is wounded.

It heals quicker than any other tissue in the body, provided all extraneous matter is removed from the wound.

Here, indeed, antiseptics work wonders.

While we are anxious to publish our success, we are prone to conceal our failures; as a result, statistics are unreliable and almost worthless on this subject.

The cerebral substance is still a puzzle. Its functions have been studied and analyzed for centuries by the greatest minds in the profession; but has it yet been shown what the changes are in its organization in insanity, or how we can explain why in one instance a small clot will induce alarming symptoms, and in another an immense effusion in the same location will develop no trouble whatever, as far as mental disturbances go?

At one time we will find that a small depression involves loss of consciousness; at another our patient walks to hospital with nearly the whole side of his head kicked in by a horse, or driven in by a blow.

A small bullet entering a frontal lobe will occasion immediate death, when at the post-mortem scarcely any hæmorrhage is found. Another has a large ball shot clear through the brain and makes a good recovery.

I believe that with the brain as with other organs—the lungs or kidneys, for instance—there is a volume much in excess of the immediate demands of the individual, and that it is entirely compatible with mental integrity, when circumstances require it, to remove a portion of healthy cerebral tissue.

In cases of laceration of the dura mater and where hernia is threatened, the procedure would seem entirely feasible, taking care at the same time to remove enough of bone, so that the scalp could fall downwards and lie snugly over the remaining portion. This would remove the tension and allow us to bring the fibrous lining of the skull together and remove any superfluity if necessary, so as to prevent possible future protrusion.

With those practicing in a large city or in mining districts, the subject of lesions of the head is one of great interest.

With us in New York, particularly, with our streets, sidewalks, yards and areas, paved with stone; with our residences of great height, especially those buildings called flats, which go heavenwards up into the sky from six to ten stories, with the elevator cables breaking, people walking carelessly into the open shaft, and others falling down a few steps, we are almost daily reminded of the importance of this study.

Among our working population those injuries are very common, owing partly to their occupations as mechanics and laborers engaged in the construction of high buildings. Skull injuries are also fearfully frequent in tenement districts, where people have to dry their clothes on the housetops, and often go there themselves to escape the stifling heat in their pent up quarters of a hot summer's night. The mother leaves her little ones on the casing of the fire-escape, on the shady side of the building, while she goes about her household duties. One of the little ones gets on the railing, loses his balance, and goes towards the yard, to be picked up perhaps dead, or, if the height has not been great, with a fracture of the cranial vault. I mention height, for I find the greater the height, the more certain is the head to reach the ground first.

In falls of ten or twenty feet the extremities come first and break the force of the fall.

With our sixteen hundred thousand population and an average of more than one hundred and twenty deaths a day, I have learned through Dr. Roger S. Tracy, our excellent Registrar of "Vital Statistics," that there were, in the year 1888, six hundred and sixty-nine (669) deaths reported as having been caused directly by either falls or blows. Out of this number two hundred and eighty-one (281) were due to fractures of the skull.

If we include pistol-shot wounds of the head ending fatally (27), and those deaths following the use of the trephine—there are none of the latter formally reported—we would have more than three hundred, or nearly half, about 43 per cent. of all deaths from violence due to falls and blows followed by lesions of the encephalon.

Of the whole number of cases which have come under my observation in the 99th Street and Harlem Hospitals, there were 113 males,

5 females. Number caused by falls, 47; number of those who died, 20. Number of fractures caused by blows and missiles, 41. Number recovered, 51. Number died, 20. Pistol-shot fractures, 8; 3 recovered; 2 improved, and 3 died. Of the 29 cases entering the hospital comatose, 8 recovered and 21 died. Out of 33 entering the hospital conscious, but shortly becoming irrational, 9 died. Twenty-four were more than fifty years old; of those but 5 recovered and 2 improved; 26 were under twenty years, and of those 17 recovered and 9 died. The oldest patient was 74 and youngest 2 years; both died. Number of cases trephined, 32; 15 recovered; 8 died. Number followed by cerebral hernia, 9. Of those, 2 died later, and 2 had, leaving the hospital, epileptic fits. Number of trephine cases, followed by unclosed opening in the skull, 11.

